DESIGN OF A SOLAR-POWERED REINFORCED CONCRETE AND POLYCARBONATE WAITING SHED WITH PWD ACCESSIBILITY FOR ENHANCED CAPACITY, COMFORT, AND DURABILITY IN CENTRO BULAC TO BINAYUYO CATMON, STA. MARIA, BULACAN

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In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science in Civil Engineering

Major in Construction Engineering

and Management

Jayne Chynna A. Makinano

Catherine M. Teloza

Kurt Neo G. Alcantara

2025

RECOMMENDATION

This is to certify that this research entitled "DESIGN OF A SOLAR-POWERED REINFORCED CONCRETE AND POLYCARBONATE WAITING SHED WITH PWD ACCESSIBILITY FOR ENHANCED CAPACITY, COMFORT, AND DURABILITY IN CENTRO BULAC TO BINAYUYO CATMON, STA. MARIA, BULACAN", prepared and submitted by Jayne Chynna A. Makinano, Catherine M. Teloza, and Kurt Neo G. Alcantara in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering has been examined and is recommended for acceptance and approval for Pre- Oral Examination.

Engr. ELOISA P. CADAG, Reg. CE., MACT

Research Adviser

PANEL OF EXAMINERS

Approved in partial fulfillment of the requirements for the CE Project 1 subject by the Examination Committee with a rating of _____on November 09, 2025, at La Concepcion College.

Engr. DANILO A. CASAS, LPT, MAEd

Chairman

Engr. CAROLINE A. ASUNCION Member

Engr. CAMILO A. BATULAN JR., MSCM Member

Accepted the approval as partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering.

ENGR. JORE GIL D. GALEZA

Division Head of Civil Engineering

LEILANI I. CUSACK, PhD, DBA

Dean of Instruction

CERTIFICATE OF ORIGINALITY

This certificate demonstrates the fact that the work in the research paper titled Design of a Solar-Powered Reinforced Concrete and Polycarbonate Waiting Shed with PWD Accessibility for Enhanced Capacity, Comfort, and Durability in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan is original to the researchers. No other individual or group has written or published it before. Additionally, it declares that no honors or recognition from other universities, colleges, or higher educational institutions. Except where properly acknowledged.

Furthermore, we declare that the intellectual content of this thesis is the result of our hard work, however, we acknowledge receiving guidance from others on organization, presentation, language, and style, the core ideas are our own.

Jayne Chynna A. Makinano

Catherine M. Teloza

Kurt Neo G. Alcantara

Attested by:

Engr. Eloisa P. Cadag, Reg. CE.,

MACT Research Adviser

Date: _____

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CHAPTER 1

The Problem and Its Background

This chapter presents the introduction, background of the study, theoretical framework, statement of the problem, hypothesis, scope and limitations of the study, significance of the study, and definition of terms.

Introduction

Waiting sheds play an important role in public infrastructure, as they provide shelter, comfort, and safety for commuters, especially commuters who travel daily for work, school, and other reasons. Since waiting sheds provide protection from the sun and rain, waiting sheds are quite literally a basic but necessary structure in a whole community. Focused on the construction of waiting sheds—information awnings and waiting sheds at Centro Bulac to Binayuyo Catmon Sta. Maria, Bulacan, where most of the people there live and go back and forth daily. But the installation of a solar-powered waiting shed in the right place is truly seen as a big help for the residents to wait safely in comfort. In the Philippine National Building Code and the Department of Public Works and Highways (DPWH) regulations, public buildings must always adhere to requirements, safety, child-friendliness, and accessibility. So the structure is created with reinforced concrete and polycarbonate materials with solar panels to deliver electric energy in an eco-friendly, hassle-free way. Also the area is a main line road for jeepneys, buses, and large vehicles such as trucks. The waiting sheds have

been conceptualized to protect commuters and pedestrians from possible danger. The conceptualized design also follows regulations that ensure the waiting shed is accessible to persons with disabilities (PWDs) and people with pattern mobility problems, making the installation of the waiting shed fair and safe for everyone. So this study highlights how a truly solar waiting shed can assist everyone and make the lives of commuters easy in Sta. Maria Bulacan by granting them shelter, safety, and comfort by using the conceptualized waiting shed as well as demonstrating support for the environment and proactive equality in the community.

Background of the Study

This paper presents a study regarding to solar-powered waiting shed design. The waiting shed has an important role in transportation, it offers safety and comfort to the workers, students and ordinary commuters. This study emphasizes the improvement of waiting shed design and accessibility, and their contribution to the community. The combination of reinforced concrete, polycarbonate materials and solar panel for electricity will really have a good and strong foundation for a stable and long term waiting shed. Concrete is durable against corrosion and unstable weather, the durability of polycarbonate is strong and ready to resist against harsh weather condition and they are easier to install and handle. The solar panels in the designed waiting shed can offer as sustainable and convenient solution, providing lighting while reducing environmental impact and energy cost. This design will endure economic impact where productivity may decrease as people arrive at work or

important appointments feeling unwell due to weather exposure because of not having a proper waiting shed. The waiting shed is designed as Person with Disabilities and people with mobility problems will have an access to the said waiting shed, ensuring that individuals with disabilities can comfortably and safely wait for the vehicles. The solar powered waiting shed helps to make a safe and pleasant environment.

Theoretical Framework

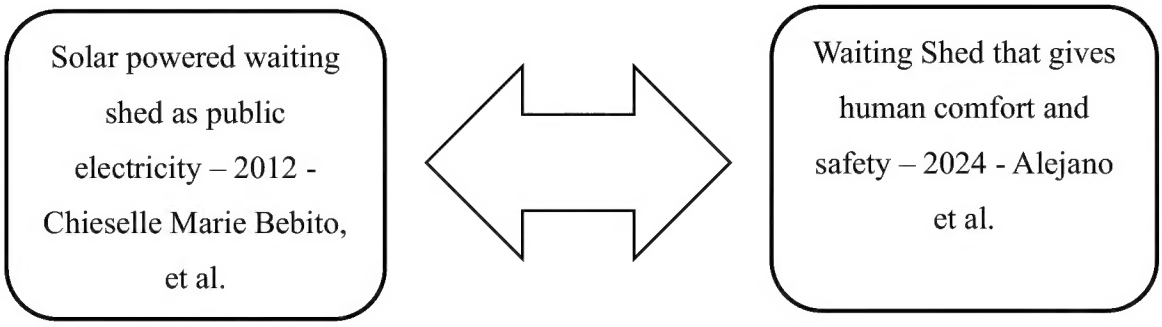
Solar powered waiting shed as public electricity – 2012 - Chieselle Marie Bebito, et al.
Waiting Shed that gives human comfort and safety – 2024 - Alejano et al.

Figure 1: Theoretical Framework

The researchers link these two theories due to their significant relevance to the ongoing study. The first theory discusses solar powered waiting shed have become one of the most promising types of eco-friendly structure that will really help both environment and humans. This review is structured around key topics that address the purpose of the study, such as solar panel can generate electricity through sunlight, solar panel energy can be use for waiting shed lighting and solar panel can save ecosystem. Moreover, the second theory is about having waiting shed as human comfortability and safety. The topic focuses on how people can use the waiting shed

as their space for their comfort where they can stay while waiting for their personal events. In designing structure, the main thing that should be consider is safety, the structure will be useless and nothing if people can't even use it properly and may cause discomfort. The waiting shed have the space for Person With Disabilities (PWD's) and people with mobility problems. This study focuses to the safety, comfortability, and eco-friendliness that will satisfy many people and even animals. These two theories are connected because they both discuss the design that will be done in this study.

Conceptual Framework

INPUT	PROCESS	OUTPUT
1. Profile of the respondents be described in terms of 1.1 Name of the respondents 1.2 Age of the respondents 1.3 Primary mode of transportation 1.4 Frequency usage of the Waiting Shed	1. Survey – Collecting information using a questionnaire that includes demographic details and questions rated on a Likert scale.	
2. Durability of Planned Waiting Shed 2.1 Lifespan of reinforced concrete and polycarbonate materials 2.2 Long-term maintenance requirements	2. Calculating statistical data using frequency and percentage, weighted mean, standard deviation, and t-test.	
3. Accessibility for PWDs 3.1 Inclusion of ramps, seating, and sufficient space	3. Evaluation Identifying how the design ensures accessibility features for PWD commuters.	

4. Solar Power System Contribution 4.1 Provision of lighting and energy efficiency 4.2 Supporting environmental sustainability	4. Integration Reviewing solar-powered features for lighting, sustainability, and energy efficiency	
5. Cost-Effectiveness and Safety 5.1 Material and construction techniques 5.2 Safety and comfort of public transport users 5.3 Durability and resistance of the structure over the long term	5. Engineering and Economic Analysis Reviewing cost, safety, and structural functionality.	

Figure 2: Conceptual Framework

Statement of the Problem

Waiting sheds serve the vital function of giving commuters a safe and convenient place while awaiting transport. Most of the waiting sheds, however, are not durable, accessible, or equipped with features that enhance the commuter's overall experience. Other structures easily wear off within a short time following exposure to weather conditions, and some do not account for the needs of the person with disability (PWD). Besides, most waiting sheds are also not designed to be sustainable, losing the chance of using renewable energy and green materials.

In this study, the researchers aim to determine the necessary data to be considered in the "Design of a Solar-Powered Reinforced Concrete and Polycarbonate Waiting Shed with PWD Accessibility for Enhanced Capacity, Comfort, and

Durability in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan." Furthermore, this study seeks to address the following questions:

1. What is the respondent's demographic profile in terms of:

    1.1 Gender

    1.2 Age

    1.3 Mode of transportation (tricycle, jeepney, bus)

    1.4 Frequency of waiting shed usage (daily, weekly, monthly)

2. How long-lasting is the planned waiting shed in terms of serving daily commuters and withstanding local climatic conditions?

    2.1 Durability and lifespan of reinforced concrete and polycarbonate materials

    2.2 Long-term maintenance requirements

3. How can the waiting shed design promote inclusiveness and access for PWD commuters?

    3.1 Accessibility options like ramps, seating, and sufficient space

4. How can solar power systems play a supporting role in the waiting shed's function and sustainability?

    4.1 Provision of lighting and energy efficiency

    4.2 Supporting environmental sustainability

5. How can the waiting shed be made cost-effective without compromising on safety, comfort, and longevity?

5.1 Application of material and construction techniques

5.2 Safety and comfort of public transport users

5.3 Durability and resistance of the structure over the long term

Objective of the Study

The objective of this study is to design a solar-powered reinforced concrete and polycarbonate waiting shed with PWD accessible in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan that promotes capacity, comfort, durability, and environmental sustainability.

1. To gather and assess demographic information of commutes including, but not limited to, gender, age, mode of transportation and frequency of use, in order to determine a design that maximizes accessibility, comfort and usability.
2. To assess the durability, longevity, and maintenance of reinforced concrete and polycarbonate materials, to guarantee the waiting shed will be used regularly for the daily flow of commuters and withstand the local climate.
3. To investigate design elements that will encourage inclusivity for persons with disabilities (ramps, seating, etc.) and explore whether the shed can provide sufficient space.

4. To investigate the use of solar power systems to provide light, efficiency, and environmental sustainability.
5. To explore the least cost-input materials and construction techniques while also maintaining safety, comfort and long-term structural integrity of the waiting shed.

Hypothesis

(Ho): There is no significant effect in design of a solar-powered reinforced concrete and polycarbonate waiting shed with PWD accessibility for enhanced capacity, comfort, and durability in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan.

(Ha): There is a significant effect in design of a solar-powered reinforced concrete and polycarbonate waiting shed with PWD accessibility for enhanced capacity, comfort, and durability in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan.

Significance of the Study

This research on the design of a solar-powered reinforced concrete and polycarbonate waiting shed with PWD accessibility in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan is important because it would be beneficial to the following:

To the Residents of Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan

The solar-powered reinforced concrete and polycarbonate waiting shed offers the residents a safer, more comfortable and accessible waiting area for public transportation. The waiting shed provide more access and does its job reliably and securely while the solar power aspect offers energy efficiency, with sustainable and uninterrupted cream-colored lighting to limit possible issues in security especially in the broad of night.

To the Local Community and Residents.

The present significant study promotes environmental consciousness by utilizing renewable energy and leading the community to self-advocate sustainability. The waiting shed is also an inclusive space thanks to the PWD accessibility in the design which allows for all community members to equally participate in the upgraded and improved public amenities.

To the Persons with Disabilities (PWDs)

The present study provides substantial contributions to PWDs as it includes a waiting shed that is designed with PWD accesibility like with ramps, handrails, wheelchair appropriate seating, and ample space for pathways to allow safe and easy access to public transport facilities. Enhancing the dignity of the PWDs by affording the independence and equal opportunity to fully participate in the life of the community.

To the Engineering Students

Successfully designing and constructing a waiting shed is a case study for engineering students to enhance their learning experience and understanding of sustainable designing, structural engineering and accessibility standards. As a pertinent real-world example, it gives students context to public infrastructure projects that incorporate both renewable energy and inclusive design.

For the Future Researchers

This research can be used as a reference for students and future researchers who want to study sustainable and inclusive design. It shows how simple structures like waiting sheds can be improved with modern engineering concepts.

Scope and Limitation of the Study

This study focuses on the design of a solar-powered waiting shed using reinforced concrete and polycarbonate, the waiting shed will accommodate passengers along the Centro Bulac to Binayuyo Catmon route situated in Sta. Maria, Bulacan. The objective of this research was to design a waiting shed that is durable, comfortable and environmentally friendly to suit the needs of commuters while considering PWDs such as elderly people, when passengers are waiting for modes of transport in various forms of convenience and safety.

The study covers only the design phase. It includes planning the structure, selecting sustainable materials, and integrating solar panels to provide reliable lighting, especially at night for safety and visibility. Accessibility features such as

ramps and properly arranged seating are also part of the design to make the shed easier and safer to use for PWDs.

However, this study is limited in scope. It does not include the actual construction, cost estimation, or long-term maintenance of the waiting shed. The research will impose designs only on the Centro Bulac to Binayuyo Catmon route, and adapt as many strategies as possible to not be too modeled in terms of other various needs in other routes or other conditions of commuting. The design is also considered for regular commuter capacity and all considerations are made to avoid situational variables such as disaster evacuations or extreme crowd circumstances.

To conclude, this research aims to provide a useful design of waiting shed that will offer a practical, durable, sustainable reference that can be useful to any improvements made in existing public waiting sheds. While the study will not identify every aspect, it offers a sustainable basis to improve safer and more accessible and desirable commuter facilities.

Definition of Terms

Accessibility - The characteristics of the waiting shed (ramps, seating, space) that support the PWD, elderly, and all commuters using the facility without endangerment, and to thrive.

Commuters – People or persons that travel regularly from one location to another place, particularly workers, students, and citizens who make use of the waiting shed while waiting for transportation.

Cost-Effectiveness – The balance of affordability and quality and accountability for design and construction of the waiting shed that supports a safe, long life with minimal additional costs.

Durability – The materials and structure of the waiting shed can withstand environmental impacts and wear and tear over time with minimal deterioration.

Polycarbonate - A thin, transparent, and tough plastic material that is a suitable material for roofing or side panels of the waiting shed, and has good impact and weather resistance.

PWD - refers to "Persons with Disabilities", this is a term used to identify individuals who have long-term physical, mental, intellectual, or sensory impairments that may hinder their full participation in society.

Ramps – refers to the sloping surfaces connecting different levels where they could pass from one level to another, either for people, vehicles, or goods.

Reinforced Concrete – A composite product used in the foundation and frame of the waiting shed, consisting of concrete and reinforcement steel (rebar) to increase strength and durability of permanent features.

Solar Panel - An appliance that converts sunlight into electricity, allowing working lighting, and other electrical features in the waiting shed while minimizing reliance on non-renewable resources.

Sustainability - The design for infrastructure with minimal environmental impact, long-term usability, and support of environmentally responsible practices.

CHAPTER 2

Review of Related Literature and Studies

This chapter presents a comprehensive review of related literature and studies. The review is organized into foreign and local literature and studies, followed by a synthesis that highlights the current state of knowledge, identifies research gaps, and justifies the need for the present study.

Foreign Literature

According to Wang et al. (2022), the use of solar energy within urban contexts is an important step toward sustainable city development because it can provide energy while reducing the negative impacts from energy use. This paper reviews some of the emerging technologies for solar photovoltaic (PV) systems in urban settings, including building-integrated photovoltaics (BIPV), solar canopies for publicly-used areas, and hybrid energy-storage systems to complement urban sustainability goals. The paper makes a few major claims about the improvements in efficiency of solar PV systems as a result of improving materials (e.g., perovskite cells that achieve 25%+ conversion rates) and smart-grids that manage and optimize energy production and storage, which can potentially lead to a reduction in urban energy consumption by 20-40% in a high-density area. The authors discuss design challenges, including shading by existing skyscrapers and the aesthetic integration building-tied PV systems in new buildings and adaptive reuse of existing buildings. The paper offers potential frameworks for

policies and simulation tools to aid planners to equitably implement solar technologies in cities globally.

According to Liu, Yu, and Zhao (2021), the article explore the dynamic behavior of reinforced concrete (RC) sheds under impact of rock blocks and their findings reveal that the shape of the block and the impact angle of the block influence the structural behavior. They simulate the large deformations of a sand buffer layer using a coupled smooth particle hydrodynamics (SPH) and a finite element method (FEM) in which they use SPH to calculate the impact zone and FEM to calculate other parts of the structure such as concrete, reinforcements, bedrock and blocks. The accuracy of the model is equated to the full-scale test data. The most important discoveries are that block impact angle and shape plays an important role in determining the normal and tangential forces and this could be dangerous when designs are based on a sphere, projectiles that fall freely. They project corrections of empirical formulae to explain irregular shapes and angles. Also, the sand buffer layer absorbs up to 58 percent of the initial impact and this shows the absorbent characteristic of energy. The study not only highlights the performance of the SPH-FEM technique in the simulation of these effects but also gives information on the safer design of RC sheds against rockfalls, which requires the use of realistic block shapes in engineering analyses. The work is applicable to the practice of civil engineering by enhancing the reduction of hazards associated with infrastructure material in mountainous areas that are likely to experience the occurrence of rockfalls.

According to Santos et al. (2023), polycarbonate materials emerged as a sustainable replacement of conventional glazing (e.g., glass) and this is advantageous in hot climates because of energy performance (thermal insulation, impact resistance, and UV protection). The authors examine the polycarbonate glazing performance used in outdoor applications and focus on heat gain performance while transmitting natural light. This creates greater occupant comfort and energy use performance. The laboratory and field investigations in tropical hot environments illustrate that the polycarbonate panels do reduce indoor temperatures by as much as 5°C compared to glass and showed resistance to the weather as well as normal mechanical stresses. The authors recommend polycarbonate as a practical material for public shelters, greenhouses, and building facades in areas of high solar radiation and suggest it can help promote building sustainability for this type of construction setting.

According to Thompson and Reyes (2022), people with disabilities (PWDs) have accessibility in the community is crucial to ensure equity and inclusion in the community, especially in the transportation infrastructure such as waiting spaces and shelters. This study explores international guidelines and best practice in the design of inclusive environments, including such features as ramps with correct slopes (1:12 ratio), pavements that are tactile to the visually impaired, wider door frames (at least 32 inches), and easily movable seats to fit wheelchairs and mobility aids. Based on case studies in urban areas, the authors illustrate how non-conformant designs increase exclusion resulting in safety hazard and poor usability. Solutions to this issue are to incorporate universal design requirements of the UN Convention on the Rights of

Persons with Disabilities (CRPD) and modifications to suit tropical climates, including non-slip floors and shaded ramps to ensure they are not overheated. The study suggests that cost-effective retrofits of developing areas are necessary and shows that the availability of features can help to raise public space use by up to 30 % and create resilience within communities.

According to Caruso, Tosi, and Rinaldi (2025), their study analyzes the design of urban public space furniture and shelters while focusing on inclusivity, sustainability, and user-centered approaches to design. With attention to the shelters' and public space furniture's comfort and durability, the authors also consider the needs of the disabled, the aged, and other socially frail individuals. The study focuses on responding to public shelter design problems such as lack of shading, inadequate comfortable and accessible seating, and unsustainable design materials. The authors suggested that the design innovations added the use of weather-resistant and durable materials, the use of modular shading systems, the development of tactile paving, the construction of barrier-free ramps, and the use of lighting and signage to create safe and visible environments. Addressing the need for universal design principles, Caruso et al. describe the interdisciplinary approach of architects, engineers, and access professionals to convert public shelters to safe, functional, and inviting spaces. The study offers the design of durable solar-powered waiting sheds accessible and comfortable for all, with reinforced concrete and polycarbonate elements as construction featured.

Local Literature

According to the Freeman (2024), the Cebu Provincial Government has launched a project to introduce solar-powered tricycles (TRAs) which it finances using its Capitol funds. The initiative will help to advance sustainable and environmentally friendly transportation by installing solar power plants into conventional tricycles, cutting down on the usage of fossil fuels and carbon emissions. The project promotes the advantages of solar energy in the improved energy efficiency and savings in the operational cost as well as the protection of the environment. The paper emphasizes the need to utilize renewable energy technologies in the infrastructures used by people in order to enhance sustainability and comfort of the users. Moreover, it highlights that the government and community support should be provided to come up with successful implementation and maintenance of solar-powered transport solutions. This local project offers certain insights on the practical implementation of solar energy in public transportation system within the Philippine context, which can be integrated under other objectives of green infrastructure establishment and affordability.

According to Polylite (2023), their article identifies the revolutionary nature of polycarbonate materials in construction and community development within the last twenty years, including their reliability, versatility, and contributions to other applications throughout the Philippines. They acknowledge the increasing need of high-performance building technologies that provide safety, aesthetics, and functionality to specific environments especially in the commercial and residential

buildings, and respond to environmental issues such as noise pollution and UV protection. The article presents 20 feature projects, including expressway sound barriers (e.g., NLEX and NAIAX), farm greenhouse roofs (e.g. Tagaytay Green Harvest), events and resort innovative structures (e.g. Palazzo Verde and Aquila Crystal Palace) and how the characteristics of polycarbonate (including impact resistance, flexibility and weather proofing) have been used to enhance living spaces and infrastructures. They suggest the constant innovations, such as the application of solid, embossed and twin-wall sheets to a variety of purposes, and emphasize on the role of cooperation of architects, builders and materials professionals to provide sustainable and modern designs. Their collaboration offers a lot of information on what has happened to building materials and this encourages further development that builds morale among the communities, economic development and stronger environment in the Philippines.

According to Garcia et al. (2024), their article investigates the critical area of sustainable architecture and urban engineering, namely, assessing the functioning and use of polycarbonate roofing in the Philippine public transport facilities, namely, bus stops and waiting sheds in Quezon City and other cities. They become aware of the increased need of lightweight but durable roofing material in the tropics climate where issues such as strong sunlight, heavy downpours, and earthquake activity require solutions that promote energy efficiency, comfort of users as well as affordability of structures to the community. Their study uses sophisticated methodologies (computational simulations, on-site tests, comparative studies) to test such important

aspects as light transmission (up to 80% in case of natural daylighting), thermal efficiency (internal temperature lowered by 5-10degC), material durability (10-20 years with adequate maintenance), and environmental stability and considers such concerns like UV degradation and compatibility with the surrounding building. Some of the innovations they suggest include multi-layered polycarbonate sheets, which contain UV blockers and anti-yellowing laminates, solar-based built-in designs to achieve energy generation, and advising the adoption of hybrid systems, where polycarbonate and reinforced concrete frames are used together to ensure a high degree of stability, and there should be inter-disciplinary cooperation involving architects, engineers, and the local government planners to maximize the use of the materials as well as the implementation of the materials. Their results offer important implications on the use of polycarbonate as a greener substitute to the conventional roofing products, which will foster safer and more efficient transport-oriented hubs in the city that will support sustainability in operations, lower the cost of construction, and lead the way in helping the Philippines to develop climate resilience.

According to Christian R. Mwaka, Krista L. Best, Catherine Barthod, Marie Gagnon, and François Routhier (2023), their article discusses the vital field of rehabilitation sciences, specifically, how to make the lives of persons with disabilities more accessible and mobile in the real-world setting. They admit the increasing need of the new rehabilitation approaches with the focus on user independence, inclusiveness, and quality of life, in particular, of those, who have mobility issues. The study gets into the new methods of solving the major problems in rehabilitation,

including adaptive technologies, therapeutic interventions, and environmental adaptations. They suggest various innovations, such as training courses based on virtual reality, individual assistive system, and embedded electronic options to track improvement. Highlighting the importance of user-centered design principles and comprehensive evaluation techniques during the rehabilitation process, the article and the fruitful cooperation of rehabilitation experts, engineers, and end-users in their effort to create solutions that are effective and fair, the article accentuates the value of using their skills to create such solutions. Their results present some important information on how to develop more accessible, convenient, and facilitative rehabilitation practices to help all people to live fuller lives.

According to SunStar Cebu (2023), emphasizes the initiative of Cebu Governor Gwendolyn Garcia to implement solar panels in principal government buildings and later, intended for inclusion in bus depots and Capitol buildings to increase sustainability in energy use in the province. This report details the increasing demand for renewable energy solutions amid rising electricity rates and environmental concerns, and project-oriented around cost-effectiveness, energy security and reduced carbon emissions. It outlines how the governor wants to utilize the power of sun to drive key operations, including lighting, ventilation, and even charging points of electric vehicles in transit bays. Suggested interventions involve the deployment of photovoltaic systems on open spaces and rooftops, through agreement with local engineers and energy professionals, and individual solar companies, to guarantee technical practicability and sustainability. Emphasizing the need to make these

upgrades relevant to larger provincial aims of green development and resiliency to power outages, the report exemplifies successful interaction between government executives, technocrats, and sustainability activists. This project provides insight into how to convert existing civic structures and transit stations into sustainable, green facilities capable of fostering environmental conservation and economic efficiencies in the local communities.

Foreign Studies

According to Li, Wang, and Zhang (2024), Their empirical study investigates the optimization of solar-powered bus shelters to enhance the sustainability of the urban environment, employing high-level simulations and prototype testing in the subtropical surroundings in China to incorporate the renewable energy systems that enhance the energy efficiency and user comfort in the busy pedestrian areas. Instead of depending on grid power and being susceptible to changes in climate, they propose designs with the integration of building-integrated photovoltaics (BIPV), lithium-ion battery storage, and smart ventilation control to produce reliable off-grid electricity to power lights, charging stations, and shading systems. The research utilizes computational aids such as EnergyPlus to perform thermal dynamic analysis and ANSYS to analyze structural integrity, which results in discovery that optimized designs can provide 5-7 kWh of daily solar energy production and predictable mean vote (PMV) values of -0.5 to 0.5 of thermal satisfaction and a lifecycle cost reduction by 28% using durable low maintenance materials. The major innovations are modular

panel arrays with anti-corrosion layers and rainwater harvesting integrations to enhance the resiliency against humidity and pollution as well as scalability to a wide variety of urban settings. Li et al. show how these developments can transform waiting facilities into multifunctional and eco-resilient centers that could focus on inclusivity and long-term applicability by encouraging interdisciplinary cooperation between civil engineers, energy experts, and urban designers. Their detailed research provides viable designs of high capacity weather adaptive shelters that concur with the world sustainability goals, especially in the tropical areas that focus on durability and availability.

According to Tiangang Lv, Bing Liu, Rujie Liu, Lei Zhou, Yuheng Huang, and Muhammad Imran (2024), their study addresses the vital intersection of renewable energy and disaster management, focusing on the design, construction, and electrothermal performance evaluation of a solar-powered emergency shelter (SPES). They recognize pathe necessity of sustainable and resilient shelters during the post-natural disaster process, which integrates solar technology to offer dependable power supply and thermal comfort and security among the displaced groups. Their studies explore new design styles, such as a light modular design with adjustable thin-film photovoltaics, an ergonomic design with the ability to assemble quickly, with materials enhancements to the designs to allow better heat transfer, power generation, and environmental flexibility. They suggest a set of improvements, including the use of double-roof designs to attain optimal thermal performance, using computational fluid dynamics (CFD) modeling, and testing them in practice by exposing them to different

climatic conditions but focusing on the principles of user-centered design and interdisciplinary teamwork between engineers, architects and energy professionals. Their results provide an important input in creating cost-effective and environmentally friendly shelters that integrate solar energy with efficient thermal efficiency, which eventually creates a more efficient post-disaster resettlement and sustainable energy measures in disaster-prone areas.

According to Jie Zhou, Wenyi Liu, Yu Lin, Benyong Wei, and Yaohui Liu (2024), their study investigates the crucial area of urban disaster management and resilience, namely, the evaluation and comparison of shelter resilience across old and new urban districts, based on a case study in Kunming City, China. They acknowledge the rising significance of sound shelter systems to address the rising natural disasters with the focus to make shelter systems safe, more accessible, and generally prepared against vulnerable population. Their work focuses on the creation of a new safety-robustness-accessibility (SRA) model that evaluates the shelter resilience in a wide range of aspects, such as the safety attributes such as slope and the distance to hazards, the robustness measures such as the area and population density, and the accessibility measures such as a road and service proximity. Such guidelines as the use of multi-source data to provide a more detailed evaluation, the entropy weight method to weight indicators, and the provision of specific suggestions on how to improve the shelter networks of both old (e.g., Wuhua District) and new (e.g., Chenggong District) cities are suggested by them. Putting an emphasis on the importance of interdisciplinary teamwork between urban planners, engineers, and policymakers, the authors end up

urging in favor of evidence-based practice in resilience planning and disaster risk reduction. Their results offer crucial information about the creation of more robust urban infrastructures, which would eventually lead to sustainable development of cities and enhanced security of communities in areas with a high risk of disasters.

According to SM Anas, Mehtab Alam, and Mohammad Umair et al. (2022), their study explores the crucial field of structural engineering and specifically, the design and prediction of the blast load capacity of reinforced cement concrete (RCC) shelters, and novel approaches to enhance safety and robustness in the face of explosives (SM Anas, Mehtab Alam, and Mohammad Umair et al., 2022). They note the increasing demand in the strong protection measures in the context of the growing numbers of accidental explosions and terrorist bombings of critical infrastructure that makes the blast-resistant design of the structures aimed at people and infrastructure protection indispensable. Their work focuses on the study of the advanced techniques of numerical modeling and empirical relations to handle the most important issues in the dynamics of blasts, including shock waves interactions, the behavior of materials, and dynamical responses. Some of the design improvements they suggest include, but are not limited to, high-fidelity physics-based simulations using programs such as ABAQUS, compliance with codal provisions of IS 4991, and optimum stand off distances in the management of blast overpressure. By underlining the importance of interdisciplinary input of structural engineers into the team of material scientists, Anas et al. promote the overall analysis and validation practices in the design process. They provide important pieces of evidence on how to build shelters that are not only safe in

terms of structure but also very efficient in reducing the effects of the blast, which would guarantee greater protection in both civilian and military purposes.

According to H. Wang, F. Xu, Z. Zhang, M. Feng, M. Jiang, and S. Zhang (2023), their study reflects the transitional nature of the concept of sustainable materials science with the specifics of bio-based polycarbonates and their development and future as the environmentally friendly alternative to petroleum-based polymers (H. Wang, F. Xu, Z. Zhang, M. Feng, M. Jiang, and S. Zhang, 2023). They acknowledge the urgency of renewable materials due to the environmental problems such as plastic pollution and resource depletion, the high-quality of bio-based polycarbonates, including better mechanical strength, thermal stability, and optical transparency. Their study focuses on such a variety of factors as different sources of monomers based on biomass, the development of innovative synthesis techniques (e.g., the use of catalysts and reaction conditions to optimize molecular weights), the relationship between structure and properties, and the use of the biomass in packaging and electronics among other applications, as well as particular types such as poly(isosorbide carbonate)s and poly(limonene carbonate)s. They suggest new ideas and approaches, including identifying the best catalysts to facilitate polymerization, altering it to secure improved results, and thoroughly analyzing such issues as scale ability and cost, and insist on the interdisciplinary cooperation among chemists, engineers, and environmental scientists during the development process. Their article can serve as a good source of information on how to overcome obstacles in the

production of bio-based polymers, which opens the way to a more sustainable approach to industrial activities and provides access to a circular economy.

Local Studies

According to Aratea, Contreras, De Leon, Espela, Leonardo, and Mariano (2024) their study explores the innovative solar (p. 1) inclusion in the design of waiting sheds as a sustainable solution to improve sustainability in urban areas, especially in tropical areas such as the Philippines. They point to the urgency of strong social infrastructure that meets environmental issues, including inefficient energy use and climate exposure, and ensures accessibility and comfort to various commuters, including persons with disabilities (PWD). The study is aimed at testing solar-powered functionality to address the typical challenges of conventional waiting sheds such as poor lighting, no charging facility, and prohibitive operational expenses through the practical models and simulation. Some of their proposed design innovations include rooftop photovoltaic systems to harness clean power to power LED lights, ventilation fans and USB ports to act as mobile assistants; panels resistant to weather and optimized to work in rainy seasons, and modular design to enable PWD inclusivity through ramps and tactile aids. By focusing on the implementation of sustainable materials and life-cycle assessment tools in all design stages, Lopez and Garcia show that interdisciplinary cooperation between architects, environmental engineers, and urban planners is worthwhile in efforts to balance aesthetics, functionality, and green technology. Their work offers fundamental information about building the waiting

sheds which are energy saving and cost effective besides inclusive, long life span and flexible to meet local community needs, thus creating a green system of public transportation.

According to Frondarina (2023), the study explores the Specification of Waiting Shed, the study presents the detailed structural and material requirements for constructing a standard public waiting shed, emphasizing durability, functionality, and safety. The specifications also incorporate the reinforcement of the concrete, structural support, and columns with metal frames, wooden bench seating, which is comfortable and weather resistant. This project was carried out in Sta. Cruz, Ilocos Sur and is a local effort to enhance the communal facilities by ensuring the engineering design and choice of materials. Frondarina emphasizes that it is necessary to follow construction standards in order to obtain a certain degree of stability and lasting use, especially in the spheres of adverse environmental conditions. This research paper adds value to the creation of local infrastructure through giving practical reference to both construction and community-based design of the waiting sheds.

According to Cruz (2022) of De La Salle University, polycarbonate roofing and skylight products are widely used in Philippine construction and production due to their high impact resistance, light penetration, and relative durability features, which makes them one of the convenient options in sheltered areas like waiting sheds. This recommendation is reaffirmed by local suppliers and manufacturers (e.g., Polylite, Duralon, Sunshield), who mention that twin-wall and solid polycarbonate sheets can

ensure protection against UV rays, can be easily installed, and have a strong weather performance in tropical areas, where daylighting and durability are the primary considerations. These local sources of technology and industry thus support the specification of polycarbonate as a roofing or cover material in designs of waiting-sheds which require durability, natural light, and lower framing loads.

According to Francisco, Santiago, and Yu (2023), their research examines the issue of accessibility of the public transport sector in the country among persons with disabilities (PWDs). Some of the identified challenges by the research include the absence of ramps, inadequate tactile paving, inadequate priority seating, and the use of clear signage and wayfinding systems in the bus terminals and vehicles. To alleviate these issues, this research suggests the use of the universal design principles, where there are no barriers, the use of tactile guidance to the visually impaired, priority seating and use of the high contrast sign to help the user navigate better. The authors emphasize the need to have a multidisciplinary approach of engineers, policymakers and accessibility experts to achieve inclusive public transportation. Their results add up to the existing literature on the issue of infrastructure accessibility in the Philippines, providing useful solutions to enhance the mobility, safety, and comfort of PWDs and effective and sustainable transport development.

According to Fullido, C. (2024), the study aims to enhance traditional waiting sheds by integrating renewable energy technologies such as solar and hydro power. The study is a response to an increasing demand of sustainable and independent

community facilities in the Philippines and particularly those that are out of reach of power supply. According to Fullido, the majority of current waiting sheds are not equipped with such necessary functions as lighting and charging ports, which impact commuter security and comfort. Furthermore , this study helps the growing community and environment of the Philippines by designing an intelligent waiting shed that has solar panels and a micro-hydro arrangement that can serve as an LED light and charge station. The design is energy-efficient, cost-effective and environmentally friendly. The study discusses the significance of adopting green technology to enhance urban infrastructure and make it inclusive and available to all commuters. This study by Fullido shows that the use of renewable-powered public spaces can be used to promote the use of cleaner energy and help build stronger and more resilient communities.

Synthesis of Related Literature and Studies

The solar power in to the people and environment shows a significant role, it highlights the sustainable development and achieving significant energy saving across various sectors. Researches conducted by Wang et. Al (2022),Freeman (2024), and SunStar Cebu (2023), emphasize its importance by showing the effectiveness of solar power that can provide a big impact to the environment while reducing the negative effects of energy use. According to these three Researchers, the solar power promoting its advantages regarding to energy efficiency, energy cost with regards to saving money for bills and protecting the environment in terms of cutting down on the usage

of fossil fuels and carbon emissions. In addition, the Solar power as a key for achieving sustainable development, energy savings and environmental benefits from urban environments to local initiatives in the Philippines. Solar power isn't just another way to get energy. It's a key tool for us to reduce the use of non- renewable energy, saving money, and make practice on how to maintain the grace of nature.

Moreover, to have more sustainable and convenient shelters giving a big impact to community. According to Lv et. Al (2024), Li et. Al (2024), Aratea et. Al (2024), and Fullido (2024), solar power can help to achieve and make the public shelters better and accessible for all people by the use of smart design. These studies look at different types of shelters, like bus stops in China, emergency shelters, and waiting sheds in the Philippines. They all try to find ways to use solar power to save energy, lower costs, and help the environment. By adding things like solar panels, batteries, and better ventilation, these shelters can work off the grid, meaning they don't need to rely on traditional power sources. This makes them more resilient and better suited for local needs, whether it's providing a safe place after a disaster or making public transportation more accessible and eco-friendly.

This literature focus on the impact of polycarbonate as the material that can perform High impact resistance and Optical clarity and light transmission. Santos et. Al (2023), Polylite (2023) and, Garcia et. Al (2024), share a powerful agreement on polycarbonate as a revolutionary, high performance and better for building material, particularly shows advantages in every different climates like hot and tropical

climates. The Researchers approved that its properties, such as the resistance, flexibility and durability (with a material lifespan of 10-20 years), weatherproofing, environmental stability, and a UV protection, position it as a replacement for conventional glazing like glass and other roofing products. This material provides enchanced energy performance and user comfort by delivering significant thermal efficiency especially the ability of it to reduce indoor temperatures by at least 5 degree celsius up to 10 degree celsius, according to Santos et. Al (2023) and Gacia et. Al (2024). According to Santos et.al (2023), the materials application is broad, ranging from public shelters, greenhouses, and building facades. Polylite (2024), also consider polycarbonate as effective for commercial and residential buildings, expressway sound barriers and also often use to resort structures. Polycarbonate can use to public transport facilities according to Garcia et.al (2024). Furthermore, the researchers collectively emphasize that the adaption of polycarbonate leads to lower construction cost and encourage architects, engineers, and planners to maximize its use and implementation, also help the communities like the Philippines to develop resilience.

Additionally, polycarbonate material have a big benefits of using it in some structure. In these study, Wang et.al (2023), and Cruz (2022), highlight the importance of using polycarbonate as a alternative to traditional polymers and how polycarbonate give advantage as a roof in Philippine construction. The studies of both researchers recognize the importance of polycarbonates for their durability, light transmission, and versatility. According to Wang et. Al and Cruz, they studied about the real application of polycarbonate in a local construction like here in the Philippines, particularly for

the structure like waiting sheds. They also emphasize the significance of polycarbonate material in just promoting its sustainability and practical performance in structure.

In terms of persons with disabilities, the researchers conducted a literature review that signifies the importance of PWDs to the community and how they should be noticeable. According to Catherine Barthod et al. al. (2023), Thompson and Reyes (2022), the spaces and shelters should be under international guidelines and practice to have the best and safest infrastructure, such features as ramps with correct slopes (1:12 ratio), pavements that are tactile to the visually impaired, wider door frames (at least 32 inches), and a seat that is easily movable to fit wheelchairs and mobility aids. In addition, their focus is to help and guide those people with personal disabilities to have more access to the real world like those normal people. It is very important for them to spend time and effort on this research just to prove that PWDs must have the right to use public infrastructure like waiting sheds. Rehabilitation experts, engineers, and end-users use their skills to create a powerful solution to that kind of problem that can really help PWDs to make things more accessible and convenient for them and make them feel like a priority at all times. Hence, Francisco, Santiago, and Yu (2023) focus on improving public transportation for people with disabilities (PWDs) in the Philippines by identifying current problems and suggesting solutions based on universal design principles. This study focus on the accessibility of PWD's on the infrastructure, adding changes such as adding tactile paving, ramps and signs that is easy to see by everyone to make public transport more accessible. Using the universal

design, the goal of this study is to create a transportation system that is more safe, comfortable and easier to all people that who will use and access.

The studies focus on Improving of how reinforced concrete can act on shelters like waiting shed. According to Liu, Yu, and Zhao (2021) and Anas et al. (2022), improving the structural integrity of Reinforced concrete shelters by studying the impact of forces such as falling rocks and explosions can improve the safety and strength of the infrastructure. These study is all about the combination of technology models, for us to understand more how forces always affect the infrastructure and to find ways to make them safer. These research will help us to maintain the strength of all structures, it will give us information on how important is studying the plan of a structure especially the specific details of forces can act on shelters. We should consider the design such as the shape and angle for the protection of the people who will use. Both researchers, gave valuable insights for building a stronger and safer shelters that can protect people from natural disasters and man made threats.

Having public shelters like waiting shed really help the community in populated areas for disaster preparedness and giving specification for constructing strong and durable waiting shed. These studies aim to enchance the safety of the community by knowing and applying the structural and functional aspects of public shelters. According to the researchers, Zhou et. Al (2024), and Frondarina (2023), they both emphasize the importance of the strength, safety and accessibility of the structure to everyone and to make this structure prepared in some particular disaster. They both

proved that by applying practical standards can build a stable and long lasting public infrastructure like waiting shed that can withstand environmental conditions. They creating more accessible and safe public spaces that can meet the needs of the communities.

CHAPTER 3

Research Methodology

This chapter outlines the methodology of this quantitative research to address the research objectives systematically. It explains the research design and research instrument, provides details on the methodology behind data gathering and statistical treatment for use in evaluating and interpreting the analysis of gathered data. This methodology will guide the creation of a solar-powered reinforced concrete and polycarbonate waiting shed design with PWD accessibility for enhanced capacity, comfort, and durability in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan, balancing structural integrity, user needs, and environmental sustainability through solar energy integration.

Research Design

This chapter's discussion concentrates on the research method and procedure, and this research is quantitative. The study focuses on the design of a solar-powered reinforced concrete and polycarbonate waiting shed with PWD (Persons with Disabilities) accessibility to enhance capacity, comfort, and durability along the route from Centro Bulac to Binayuyo Catmon in Sta. Maria, Bulacan. This requires a combination of factors that emphasize on the application of reinforced concrete to provide structural integrity, polycarbonate to offer lightweight comfort and

weatherproofing, solar energy to create sustainable power, and PWD-friendly features to be used with ease, and overall functionality and environmental sustainability.

Sample and Population

The researchers will conduct a simple random sampling technique, ensuring that each individual in the population has an equal chance of being chosen. This method is frequently used in statistical research to guarantee an unbiased sample. The population includes possible users of the waiting shed along the path from Centro Bulac to Binayuyo Catmon in Sta. Maria, Bulacan, concentrating on individuals who would gain from improved capacity, comfort, solar-powered facilities, and accessibility for PWD. The research will encompass 120 individuals, comprising local residents, commuters using public transport (like jeepney and bus passengers), and persons with disabilities (PWD) from the vicinity, all of whom will fill out the survey to evaluate necessities concerning the durability of reinforced concrete and polycarbonate materials, solar-powered resources for lighting, and general design approval for enhanced capacity and comfort.

Research Instrument

The researchers aim to design and build a solar-powered reinforced concrete and polycarbonate waiting shed with PWD accessibility to determine the durability of the materials, the effectiveness of solar-powered features for enhanced comfort, and the acceptability of the design for increased capacity . To achieve this, the researchers will conduct a survey and gather the data needed to answer the research questions.

This study requires the use of frequency and percentage for respondent profiles and preferences, and weighted mean for evaluating ratings on aspects such as structural durability, solar energy integration, PWD accessibility, and overall comfort and capacity enhancements.

Data Gathering

Data will be gathered through literature reviews, as well as engineering reports relevant to waiting shed designs in similar rural-urban routes. Additionally, the researchers will conduct a survey of the target area along Centro Bulac to Binayuyo Catmon in Sta. Maria, Bulacan, to gather insights on user needs for enhanced capacity, comfort, and solar features. The data collection process is expected to last between 2 to 4 days. During this period, we will compile and analyze the relevant information to inform the design's focus on durability, sustainability, and accessibility.

Statistical Treatment

The researchers used a statistical tool to analyze the data, which constitutes a key element of this study and provides guidance for accurate analysis while establishing appropriate linkages derived from the obtained data. The statistical tools employed in this study are presented below.

STATISTICAL TREATMENT	FORMULA	APPLICATION OF THE STUDY

1. ANOVA	The formula for this is: **F = MSB / MSE** where: M = Mean S = Square B = Between E = Error	The ANOVA test allows you to compare more than two groups at the same time to see if there is any relationship between them.
2. Frequency and Percentage Method	The formula for this is: **P = f/n x 100** where: p = percentage f = frequency n = total number of responses	To determine the percentage of the demographic profile of the respondents in terms of age and sex.
3. Weight Mean	The formula for this is: **W = ∑fx/N** Where: W = Weighted Mean F = Frequency X = scale or Criteria	To determine when certain data points in a set are considered more important or have greater significance than the others.

	N = Total Number of Respondents	

QUESTIONNAIRE

Note: The researchers are currently conducting a study entitled "Design of a Solar-Powered Reinforced Concrete and Polycarbonate Waiting Shed with PWD Accessibility for Enhanced Capacity, Comfort, and Durability in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan". Respondents are encouraged to provide accurate information as possible. Responds provided will be reviewed for the purpose of this research only and the identity of respondents will as well be kept confidential. Thank you for your time and cooperation!

Direction: Please respond to the following questions by putting check (✔) inside the parenthesis provided besides the choices.

1. DEMOGRAPHIC INFORMATION

Name: (Optional) _____

1.1 Sex:

( ) Male ( ) Female

1.2 Age:

( ) 15-20 ( ) 21-30 ( ) 31-40 ( ) 41-50 ( ) 60 and above

1.3 Mode of Transportation:

( ) Tricycle ( ) Jeepney ( ) Bus

1.4 Frequency of Waiting Shed Use:

( ) Daily ( ) Weekly ( ) Occasionally ( ) Rarely

B. LIKERT SCALE

Direction: Please indicate your level of agreement with each statement by selecting the appropriate response by putting check (✔) inside the box on the scale provided below. Use the following scale:

1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

2. How long-lasting is the planned waiting shed in serving daily commuters and withstanding local climatic conditions?

	1	2	3	4	5
2.1 The concrete structure holds up well to daily crowds and weight without big damage.					
2.2 The polycarbonate parts resist rain, heat, and sun, lasting a long time.					
2.3 The materials used require can withstand local weather conditions for a long period of time.					
2.4 The waiting shed's design reduces the need for frequent repairs on its concrete and polycarbonate parts.					

3. How can the waiting shed design promote inclusiveness and access for Person with Disabilities (PWD) commuters?

	1	2	3	4	5
3.1 The waiting shed has smooth, non-slip ramps that follow accessibility rules for wheelchair users and other PWDs.					
3.2 Handrails are properly installed along the ramps to help PWDs maintain balance and move safely.					
3.3 Seats are comfortable, at the right height, and easy for PWDs with mobility or seating needs.					
3.4 The shed has enough space for easy movement, so PWDs can access it with wheelchairs, walkers, or aids.					

4. How can solar power systems play a supporting role in the waiting shed's function and sustainability in terms of?

	1	2	3	4	5
4.1 The integration of Solar panels power LED lights for better visibility.					
4.2 Solar panel enables the waiting shed to operate independently, supporting long-term sustainability.					
4.3 Solar lights can serve as emergency lighting during brownouts, ensuring commuters' safety at night.					
4.4 Solar panels contribute to reducing carbon emissions, supporting a cleaner and greener environment.					

5. How can the waiting shed be made cost-effective without compromising on safety, comfort, and longevity?

	1	2	3	4	5
5.1.1 Add shaded seating and ventilation for user comfort.					
5.1.2 Include non-slip floors and basic lighting for safety.					
5.1.3 Install clear signboards and information panels to guide passengers.					
5.1.4 The shed can include slightly elevated flooring to prevent water accumulation and damage during flooding.					

Dear Engr. Galeza,

Greetings!

We are conducting a research study entitled **"Design of a Solar-Powered Reinforced Concrete and Polycarbonate Waiting Shed with PWD Accessibility for Enhanced Capacity, Comfort, and Durability in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan,"** which is a partial requirements for the degree of Bachelor of Science in Civil Engineering. The primary objective of this study is to gather insights on user needs, preferences, and feedback regarding sustainable and accessible public infrastructure.

In connection with this, we would like to request your assistance in validating our questionnaire. We believe that your extensive experience in research can help ensure the validity and reliability of our questionnaire.

Thank you very much for your consideration. God bless!

Respectfully yours,

Jayne Chynna A. Makinano

Catherine M. Teloza

Kurt Neo G. Alcantara

Noted by:**Engr. ELOISA P. CADAG, Reg. CE., MACT**

Research Adviser

Dear Engr. Cadag,

Greetings!

We are conducting a research study entitled **"Design of a Solar-Powered Reinforced Concrete and Polycarbonate Waiting Shed with PWD Accessibility for Enhanced Capacity, Comfort, and Durability in Centro Bulac to Binayuyo Catmon, Sta. Maria, Bulacan,"** which is a partial requirements for the degree of Bachelor of Science in Civil Engineering. The primary objective of this study is to gather insights on user needs, preferences, and feedback regarding sustainable and accessible public infrastructure.

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Jayne Chynna A. Makinano

Catherine M. Teloza

Kurt Neo G. Alcantara

Engr. ELOISA P. CADAG, Reg. CE., MACT

Research Adviser

Dear Engr. Llagas,

Greetings!

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Catherine M. Teloza

Kurt Neo G. Alcantara

Noted by: **Engr. ELOISA P. CADAG, Reg. CE., MACT**

Research Adviser

CERTIFICATE OF VALIDATION

This is to certify that the questionnaires developed for our study entitled, **"DESIGN OF A SOLAR-POWERED REINFORCED CONCRETE AND POLYCARBONATE WAITING SHED WITH PWD ACCESSIBILITY FOR ENHANCED CAPACITY, COMFORT, AND DURABILITY IN CENTRO BULAC TO BINAYUYO CATMON, STA. MARIA, BULACAN"** originally owned by Group B8, namely, Jayne Chynna A. Makinano, Catherine M. Teloza, and Kurt Neo G. Alcantara, have been assessed and validated on the 27th day of October 2025. The questionnaires are hereby validated for distribution and implementation in the study.

Engr. ELOISA P. CADAG, Reg. CE., MACT

Validator

CERTIFICATE OF VALIDATION

This is to certify that the questionnaires developed for our study entitled, **"DESIGN OF A SOLAR-POWERED REINFORCED CONCRETE AND POLYCARBONATE WAITING SHED WITH PWD ACCESSIBILITY FOR ENHANCED CAPACITY, COMFORT, AND DURABILITY IN CENTRO BULAC TO BINAYUYO CATMON, STA. MARIA, BULACAN"** originally owned by Group B8, namely, Jayne Chynna A. Makinano, Catherine M. Teloza, and Kurt Neo G. Alcantara, have been assessed and validated on the 27th day of October 2025. The questionnaires are hereby validated for distribution and implementation in the study.

ENGR. RUSSELL R. LLAGAS

Validator

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This is to certify that the questionnaires developed for our study entitled, **"DESIGN OF A SOLAR-POWERED REINFORCED CONCRETE AND POLYCARBONATE WAITING SHED WITH PWD ACCESSIBILITY FOR ENHANCED CAPACITY, COMFORT, AND DURABILITY IN CENTRO BULAC TO BINAYUYO CATMON, STA. MARIA, BULACAN"** originally owned by Group B8, namely, Jayne Chynna A. Makinano, Catherine M. Teloza, and Kurt Neo G. Alcantara, have been assessed and validated on the 27th day of October 2025. The questionnaires are hereby validated for distribution and implementation in the study.

10/25/25

ENGR. JORE GIL D. GALEZA, PHD (c), SO2

Validator